AMERICAN FOUNDRYMENS ASSOCIATION · FOUNDED 1896

American Foundryman

...VITIES

December 1939

Activities of the Gray Iron Division

THE Association's Gray Iron Division has recently completed a number of activities that are of benefit to all users and producers of gray iron castings. Probably the outstanding recent activity was the preparation of the material used in the book on "Alloy Cast Iron." Preparation of the material required over three years' work on the part of various committees, and the Division gratefully acknowledges its debt to those many committee workers who contributed so generously of their time and knowledge in this work. The Division is justly proud of this work and feels that it fills a real need in our literature on gray cast iron.

Another similar work was the writing of the gray iron section of the Cast Metals Handbook and more recently revision of this material for the forthcoming new edition. The handbook is the only one on cast metals available and has found widespread acceptance as the reference work on its subject. A systematic revision procedure is now being worked out so that up-to-date editions may be issued by our national office at regular intervals.

The Gray Iron Division has been particularly active in presenting numerous papers on all phases of casting production, gray iron metallurgy, sand control and related subjects. It has been necessary to limit the number of papers presented in order not to overburden the gray iron portion of the program. This has resulted in increasing improvement in the quality of the papers and permitted the Papers committee to be more critical.

Our various members and committees have been active in correlating our activities with those of other technical societies, particularly so with the American Society for Testing Materials. The present A.S.T.M. specifications for all types of gray iron castings were prepared with the cooperation of a large number of our members.

Our future activities promise to be fully as constructive as those already finished. The various committee officers and members merit our sincerest appreciation of their work. We want to urge those who have not been active committee members to become committee workers. This will benefit the gray iron industry, the A.F.A. and, most of all, themselves.

Garnet P. Phillips

G. P. Phillips, Chairman
Gray Iron Division

Garnet P. Phillips, Chairman, A.F.A. Gray Iron Division, is foundry metallurgist, International Harvester Company. He is well known for the many technical papers and discussions presented before A.F.A. national and chapter meetings and other technical societies. A graduate of Rose Polytechnic Institute, Terre Haute, Ind., he received his masters degree from Carnegie Institute of Technology. Before going with the International Harvester Company, Mr. Phillips was metallurgist with the Frank Foundries Corporation, Moline, Ill.

American Foundryman

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Entered as second class matter July 22, 1938, at the post office at Chicago, Illinois, under the Act of March 3, 1879.

Operating Foundry Exhibit Dedicated at Chicago Chapter Conference

APPROXIMATELY 550 members and guests attended the Second Regional Conference of the Chicago Chapter at the Museum of Science and Industry, Jackson Park, Chicago, November 9, 10 and 11, to assist in the dedication of the large operating exhibit of the Foundry Industry at the Museum and to attend technical sessions of interest to gray iron, steel, malleable and non-ferrous foundrymen. The conference was sponsored jointly by the Chicago Chapter and the Museum.

During the first two days of the conference, both morning and afternoon, outstanding speakers discussed subjects of current and timely interest to men in the various divisions of the foundry industry. Steel foundrymen took advantage of the occasion to hold a district operating meeting of the Steel Founders' Society of America, while malleable foundrymen likewise held a shop practice meeting of the Malleable Founders' Society. Members of these organizations, together with members of the Gray Iron Founders' Society, took an active part in the preparation of the program, which was directed by the Program Committee of the Regional Conference Committee of the Chicago Chapter. L. H. Rudesill, Griffin Wheel Co., Chicago, was General Chairman of the Conference Committee.

On Thursday evening, November 9, a general session was held

First Row—Left—A Group Inspecting the Model Foundry. Center—Another Group Around the Exhibit. Right—(Left to Right)—C. E. Westover, Chapter Chairman and Chairman of Chicago Chapter Exhibit Committee; L. C. Fopeano, Museum of Science and Industry Staff and Member of Exhibit Committee; L. H. Rudesill, Chairman of Regional Conference Committee. Center Row—(Left to Right)—(1) Electric Furnace Used to Melt Iron for the Model Foundry, (2) Pouring, (3) R. E. Kiefer Inspecting the Core-blower Unit, (4) the Cupola and Relay Equipment for Electric Furnace, (5) an Important Discussion. Bottom Row—Left—G. P. Guion, L. B. Knight, Jr., W. L. Hartley and H. W. Johnson Inspect the First Castings Made. Center—Mentor Wheat and Harold Gusloff Supervise Molding in the Exhibit. Right—The Registration Desk Was a Busy Place.

Photos, Courtesy E. F. Wiechmann, Whiting Corp.

Photos, Courtesy E. F. Wiechmann, Whiting Corp.

Left to Right—(1) A. W. Gregg and Dr. Gillett, Talk Things Over. (2) Max Becker, John Lowe, J. L. Brooks and R. E. Prussing Pose at the Museum Entrance. (3) Vice President L. N. Shannon and Ronald Webster Are Caught Unexpectedly. (4) Frank G. Steinebach Was on Hand to Report the Meeting in The Foundry

in the Museum auditorium, at which C. E. Westover, Burnside Steel Foundry Co., Chicago, Chairman of the Chicago Chapter and also Chairman of the Chicago Chapter Museum Exhibit Committee, which so excellently performed its task of assembling the equipment and materials for the model foundry, presented the exhibit to the Museum on behalf of the Foundry Industry. Dr. Phillip Fox, director, Museum of Science and Industry, accepted the exhibit on behalf of the Museum. Following the presentation ceremonies, Dr. H. W. Gillett, Battelle Memorial Institute, Columbus. Ohio, addressed the meeting on "Cupola Possibilities and Limitations for Making High Strength Irons." Dr. Gillett's address will be found elsewhere in this issue.

Following the technical sessions on Friday, November 10, over 400 foundrymen, their wives and guests, attended the Conference Dinner, Palmer House, Chicago, at which H. S. Washburn, Plainville Casting Co., Plainville, Conn., President, American Foundrymen's Association, presided and introduced the speaker of the evening, Col. Frank Knox, publisher, Chicago Daily News, who delivered a noteworthy address on "The International Situation." Col. Knox's address delt with the question of whether or not the United States would become involved in the present European situation, a very timely and interesting subject. During the course of the evening, representatives of the various organizations which had cooperated to make the exhibit possible were introduced. The organizations were the Chicago Chapter of the American Foundrymen's Association, the parent association; Gray Iron Founders' Society, Cleveland; Steel Founders' Society of America, Cleveland; Malleable Founders' Society, Cleveland; Cast Iron Pipe Research Association, Chicago, and the Association of Manufacturers of Chilled Car Wheels, Chicago.

Saturday morning was "Students' Day." About 350 students and apprentices from the various high schools, universities and industrial plants throughout Chicago attended a meeting in the Museum auditorium to see the technicolor film, "Steel — Man's Servant," and to hear F. A. Melmoth, Detroit Steel Casting Co., Detroit, speak in "Modern Castings' Application in Engineering." Following the meeting, those attending all viewed the foundry exhibit in the Museum.

Ralph MacPherran

1871-1939

RALPH STEWART MACPHERRAN, acknowledged universally as dean of metallurgists in the cast iron field, died November 13 at the home of his brother in Duluth, Minn. In ill health for some time, Mr. MacPherran had recently retired as chief chemist for the Allis-Chalmers Manufacturing Company, with which organization he had been connected for over forty years.

Outstanding for his knowledge of cast iron metallurgy, he was beloved by his host of associates and fellow workers throughout the world. In recognition of his research work in the cast iron field, Mr. MacPherran in 1931 was awarded the J. H. Whiting Gold Medal of the American Foundrymen's Association. Generously contributing of his store of knowledge, he presented many papers before various technical associations.

Born at Sterling, Illinois, Mr. MacPherran was graduated from the University of Michigan in 1892 with the degree of B.S. in chemistry. For three years after finishing at Michigan he was associated with the Illinois Steel Company at both the Joliet and South Chicago Works. In 1895 he became connected with the

E. P. Allis Co., Milwaukee, and except for one year (1907) spent at the J. I. Case Threshing Machine Co., Racine, Wis., he was connected continuously with the Allis Co., now the Allis-Chalmers Mfg. Co.

Second Edition of Cast Metals Handbook Ready for Distribution

MEMBERS of the Association will be interested to learn that the 1940 Edition of the Cast Metals Handbook now is ready for distribution. The National Office shortly will mail request cards to all members in good standing so that they may request a copy of the new volume. One copy of the 1940 edition is issued free on request to all members of the Association. Prior to January 1, 1940, non-members may purchase copies of the Handbook at $4.00 per copy. After that date, the cost to non-members will be $5.00.

The first issue of the Cast Metals Handbook was issued "to present to engineers, designers, all users of castings, editors of engineering handbooks and engineering students, condensed, authoritative and up-to-date data on cast metals. These data to be only such as will enable the user to select the material best suited for his purpose and which will give him needed information to cooperate with foundries in obtaining his castings in the most satisfactory manner." The purpose of the second edition is the same as the first. The 1940 edition is completely revised from the 1935 edition. Much new data and information has been added. Much of the new data renders information in the 1935 edition obsolete.

Therefore, to keep the information available on cast metals as up-to-the-minute as possible, the Association asks those possessing 1935 editions of the handbook to return them to the National Office so that they may be removed from circulation.

On the inside of the front cover of the new edition is a set of instructions for issuance of future editions. Each 1940 Handbook will be given a number and will be recorded in the name of the person to whom it is issued. When future revisions of the Handbook are ready, persons to whom the 1940 edition was issued will be required to return their old copy to secure a free copy of the new issue. If the copy has been mislaid or cannot be located, they will be required to pay $3.00 for the new issue. Non-members who buy the 1940 edition will be required to pay $3.00 and return their old issue in exchange for the next edition. If non-members lose their copy, they will be required to pay the list price for the next edition.

On receipt of the 1940 edition of the Handbook, persons to whom it is issued are requested to fill out the self-addressed postal card in the inside front cover and return it to the National Office to assist in keeping the records straight.

December Meeting Calendar

December 4

Detroit
Joint Meeting with Society of Automotive Engineers—E. K. Smith, Electro Metallurgical Co., Detroit; P. S. Lane, American Hammered Piston Ring Div., Koppers Co., Baltimore, Md.—*"Relationship Between Hardness, Microstructure and Wear of Cylinder Bores and Rings."*

Metropolitan New York-New Jersey
Essex House, Newark, N. J.
K. V. WHEELER, American Steel Castings Co.
"How Design Factors Affect Steel Castings"

Central Indiana
Columbia Club, Indianapolis
Chapter Organization Meeting
W. R. JENNINGS, John Deere Tractor Co., Waterloo, Iowa
"Molding Machine Production"

December 8

Buffalo
Hotel Touraine, Buffalo
HAROLD J. ROAST
"Honesty in The Foundry"

Central New York
Hotel Onondaga, Syracuse
F. G. SEFING, International Nickel Co., New York City
"Metallurgy of Cast Iron"

Metropolitan Philadelphia
Engineers Club
SAM TOUR, Lucius Pitkin, Inc.
"Non-Ferrous Founding"

Northern Illinois-Southern Wisconsin
Hotel Faust, Rockford
Christmas Party

December 11

Chicago
Medinah Club
C. C. CARLTON, Motor Wheel Corp.
"Business and Government Relations"

Quad City
Blackhawk Hotel, Davenport, Iowa
S. C. MASSARI, Ass'n of Mfgs. of Chilled Car Wheels
"Cupola Control"

December 13

New England Foundrymen's Association
Engineers' Club, Boston
F. G. SEFING, International Nickel Co.
"Nickel and Cast Iron"

December 12

Michiana
Hotel Oliver, South Bend
Ferrous: R. G. MCELWEE, Vanadium Corp. of America
"Cast Iron Metallurgy"
Non-Ferrous: H. M. ST. JOHN, Crane Co.
"Metal Bookkeeping in the Brass Foundry"

December 14

St. Louis
Hotel York
Christmas Party

Northeastern Ohio
Rainbow Room, Hotel Carter, Cleveland
Christmas Party

December 15

Cincinnati District
Hotel Alms
Dinner, Dance and Christmas Party

Northern California
Hotel Claremont, Piedmont
Joint Christmas Party with Golden Gate Chapter, American Society of Metals

Southern California
Lakewood Country Club, Long Beach
Christmas Hi-Jinks Party

Wisconsin
Hotel Schroeder, Milwaukee
Christmas Party

Cupola Possibilities and Limitations for Making High-Strength Iron

By H. W. Gillett and C. H. Lorig, Columbus, O.

This paper was presented before the 1940 regional conference of the Chicago Chapter, November 9. Dr. Gillett, honorary member, A.F.A. and 1932 medallist, is chief technical advisor, Battelle Memorial Institute. A graduate of Cornell University, he is acknowledged as one of the foremost metallurgists of the world, from 1924 to 1929 being chief, metallurgical division, U. S. Bureau of Standards. In 1929 he was appointed as the first director of Battelle Memorial Institute. Dr. Lorig, co-author with Dr. Gillett, is a graduate of the University of Wisconsin, and when Battelle Memorial Institute was organized became one of its first research metallurgists, devoting a large portion of his time to problems connected with the foundry industry.

THE signs of the times indicate that the foundryman will be under increasing customer pressure to supply high-strength, i.e., "high-test" and alloy irons. Or, if you don't agree with that phraseology, put it that the foundryman who can produce high-strength irons has a product which he can merchandise, one that opens up a field of service that cannot be entered by the foundryman who can make nothing but soft gray iron.

It has been estimated[1] that 10 per cent of the total American gray iron output of 1937 was alloyed. One would expect that an equal amount of u n a l l o y e d high-strength iron would be produced. Every sign, including the hearty reception given the A.F.A. handbook on "Alloy Cast Irons," leads to the conclusion that, and very soon, somewhere between one-fourth and one-third of the gray iron output will be some variety of high-strength iron. The attention being given in England[2] to "high duty" iron, as it is there termed, is an additional straw in the wind. The foundryman who can only supply the garden varieties of iron will find his sales outlets progressively restricted. It is time right now for foundrymen to consider how they can produce high-strength iron and lay definite plans for its production before they wake up to find their market gone. Most customers who want both common and high-strength irons for different purposes will favor that producer who can supply all their casting needs rather than only a part of them.

We may define high-strength iron as A.S.T.M. Class 40 iron, i.e., that which, in a 1.2 in. arbitration bar, shows 40,000 p.s.i. tensile strength or more, with the "or more" going up to 60,000 and perhaps higher.

Factors of Costs

In the production of high-strength cast iron, as of any other product, the cost is made up of two factors, raw materials and conversion costs. What we want is the lowest *total* cost. With prices of raw materials fluctuating as they do, it is advisable to have at our command techniques suited to different types of raw materials, so that we may shift at short notice to the combination of material and technique that is most economical.

However, one of the items in conversion costs is interest and amortization on equipment installed to give this flexibility but held idle in periods when its use is not economical.

Four Methods of Production

The foundry desiring to make high-strength gray iron has several recognized choices of doing it, e.g. (1) in the cupola by holding carbon and silicon at the necessary low levels, (2) by alloying additions to a weak iron, (3) by cold melting in or (4) by duplexing to an electric, an air furnace, or some equivalent. Each of these is commercially used.

Technically, the electric melting methods are the most easily controlled and, since they allow use of large proportions of cheap borings and turnings, the economics are very attractive whenever reasonable power rates can be had, and the furnace can be kept busy. However, the first cost of an electric is rather high so that interest charges pile up in idle periods, and this is aggravated by the demand charge for power which makes the conversion cost rise steeply when the electric is intermittently operated. Many foundrymen have therefore had to forego the convenience of the electric because they had insufficient assurance that they could keep it busy.

On the other hand, captive foundries in large production with an assured output have shown great ingenuity in developing some of the more difficult technique that can, with enough supervision, be made to give very low conversion cost.

The jobbing foundryman who is just breaking into the high-strength cast iron field is betwixt and between. He is not assured of a steady enough market to justify either buying an electric, or of developing the technique and control characteristic of the large captive foundries making non-alloyed high-strength irons. His usual way out of the dilemma is to use his regular soft iron and load it up with alloys till it meets the high-strength specifications. This is an uneconomical use of alloys. As has been stated in the A.F.A.-A.S.T.M. Symposium,[3] "Alloys should be added to a good base iron and not used in an attempt to make a poor iron into a fair one."

Application of the Duplexing Principle

In theory, at least, the duplexing principle should be applicable to the making of high-strength iron, either for use as is, or for economical alloying to make still better irons, and without the necessity of expensive equipment. It is this possibility that we are going to explore a bit.

We defined high-strength iron as that of A.S.T.M. Class 40, i.e., that which gives 40,000 tensile in a 1.2 in. bar. Chemically, in unalloyed iron, this means metal of about 3.00 per cent total carbon, 1.75 per cent silicon, with the silicon, of course varied according to section, and with some of the silicon used as an inoculating ladle addition in order to produce "normal" iron, with the proper structure.

[1] Stanley, R. C. *Annual Report*, International Nickel Company of Canada for 1938.

[2] Pearce, J. G. *1st Report Research Committee on High-Duty Cast Irons for General Engineering Purposes.* Institute of Mechanical Engineers, Session of Dec. 16, 1938, Advance Copy.

[3] *Symposium on Cast Iron*, American Foundrymen's Association and American Society for Testing Materials, 1933.

It is possible to make stronger unalloyed iron by cutting the carbon still more, and a further reduction of carbon and a different adjustment of silicon are made for pearlitic malleable, say 2.75 per cent carbon, regular malleable, say 2.50 per cent carbon, and super-strength malleable, say 2 per cent carbon, and together with suitable alloy additions for the Ford family of alloys at say 1.50 per cent carbon.

Some Base Iron Considerations

Unless some sort of malleableizing heat-treatment is to be applied, it is probably not wise to overstep the sensible mean and try to force the base iron to too high a strength. The super-strength unalloyed irons have greater shrinkage, higher melting points, and poorer castability. They offer more difficulty in getting sound castings. Since the real problem is production of castings, not test bars, taking the carbon and silicon down to the lowest possible level that will give gray castings is not necessarily the best answer. Morken[4] calls such iron "tricky."

It is possible to play the upper part of the carbon scale on the cupola, but the further we go down the scale, the sourer the notes are likely to be. Nevertheless, Judson[5] regularly makes hard iron of 2.40 per cent carbon, 1.35 per cent silicon in one cupola for mixing with soft iron from another cupola to produce a final mix of about 2.75 per cent carbon, 1.60 per cent silicon for heavy castings. MacPherran[6] regularly produces metal under 3.00 per cent carbon from the cupola. Smalley[7] also reports such cupola iron. In all these cases, the cupola charge is very high in steel scrap. There is no doubt at all that metal of the 2.80-3.10 per cent carbon range desired for high-strength iron to be cast gray can be obtained from the cupola, and cupola malleable is regularly made at this carbon level.

Neither is there any doubt that it is a tough job to make the cupola consistently produce these low carbons and at the same time produce sufficiently hot metal. Since the cupola melts the metal in contact with the coke, carbon is inevitably picked up to some level governed by the metal charge, the coke, and the mode of operation of the cupola. These factors can be more readily controlled to give the combination of hot metal and small fluctuation from the carbon level aimed at, if this level is set at, say 3.30 per cent carbon rather than 3 per cent. One might say that the average cupola under average operation is more "contented" when it "gives down" 3.30 per cent carbon.

Silicon Level

The silicon level must be held low enough so that the final "inoculating" addition can be made. The minimum addition is generally around 0.25 per cent. Hence, we may phrase the problem as the production of molten iron of 3.00 per cent carbon and 1.50 per cent or less silicon, at a high enough temperature level to take up the addition and allow plenty of time for pouring. We want to do as much as possible in the cupola because that is the cheapest melting method considering both first cost of equipment and fuel consumption. Hence, a still more precise phrasing of the problem is, the adjustment of cupola metal to the desired carbon and silicon level. By using a charge high in steel, the silicon can be kept low and the desired silicon added at a later stage, in which case the problem is merely one of lowering carbon from 3.30 to 3.00 per cent. This can be done either by oxidation of 1/10 of the carbon, or by about 10 per cent dilution with molten low carbon steel.

If one wants to divert a part of his regular soft iron of say 3.40 per cent carbon, 2.20 per cent silicon for use as a base for alteration to the high-strength composition, a large dilution would be required to bring the silicon where we want it, so it will be sensible to oxidize part of the silicon before dilution.

Oxidation Possibilities

We are talking glibly about oxidizing carbon or silicon in these two cases, as if such oxidation would not adversely affect quality, a matter that requires proof.

Yet the mere fact that the raw material has at sometime been subjected to strongly adverse oxidizing conditions need not mean that the final product is any the worse. Actually, all iron starts out as iron oxide in ore, and all steel made with blast furnace metal in the charge must be severely oxidized to burn out the carbon in the pig iron. Foundrymen know that converter steel is cupola metal oxidized in most drastic fashion before final deoxidation, yet well made converter cast steel is very good stuff. Indeed, a vigorous boil is good medicine for most cast ferrous products. There is as much reason to expect benefit as harm from an oxidizing step in production.

At any rate, when we have obtained a melt to the chemical composition desired, we have taken the first step toward putting it in proper shape for casting. Given the desired chemistry, the metallurgist can usually find out how to put on the finishing touches.

In large scale operation, the composition of cupola metal is satisfactorily adjusted through an oxidizing step. Malleable[8] has been made by blowing part of a cupola charge and mixing the blown metal with unblown metal and slightly super-heating in an electric. The Ford 1.50 per cent carbon metal for brake drums is so made at Campbell, Wyant and Cannon.

It is not necessary to use a converter, the same reaction can be brought about with solid iron oxide. Kinnear[9], following earlier published suggestions of Hall[10], and unpublished suggestions of Melmoth and Batty, duplexed cupola melts from an all-steel charge down to cast steel composition by oreing down in the basic electric. He saved half the electric energy required for a cold melt, doubled the furnace output and made good grade B steel. Such steel practice calls for desulphurizing the cupola metal, but that is no trick nowadays.

Dropping Carbon From Composition

To check the feasibility of dropping carbon from the composition which a cupola will readily "give down" from an all-steel charge, a 300-lb. melt of 3.34 per cent carbon, 0.21 per cent silicon, 0.22 per cent manganese, 0.05 per cent phosphorus, 0.10 per cent sulphur was made in a basic lined induction furnace. With the metal at 2800° F., 6.85 lb. of mill scale was added over a period of 26 minutes. When the boiling stopped, a sample analyzed 3.04 per cent carbon, 0.04 per cent silicon, 0.07 per cent manganese. Additions of ferrosilicon calculated for 1.75 per cent silicon and ferromanganese calculated for 0.50 per cent manganese were made. A sample taken after the additions had become diffused showed 2.98 per cent carbon, 1.79 per cent silicon, 0.63 per cent managanese, 0.042 per cent phosphorus, 0.084 per cent sulphur. One ladle was poured from the furnace at once, another

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[4]Morken, C. H. *Some Engineering Aspects of Cast Iron.* Mechanical Engineering, vol. 61, June, 1939, pp. 455-459.

[5]Judson, H. H. *High-Test Iron for Pressure Castings. Transactions,* American Foundrymen's Association, vol. 40, 1932, pp. 153-163.

[6]MacPherran, R. S. *High-Test Cast Iron.* Transactions, American Foundrymen's Association, vol. 37, 1929, pp. 495-500.

[7]Smalley, O. *High-Test Cast Iron.* Transactions, American Foundrymen's Association, vol. 37, 1929, pp. 485-494.

[8]Schwartz, H. A. *Malleable Made by Triplex Process.* Foundry, vol. 48, 1920, pp. 815-817, 1925.

[9]Kinnear, H. B., and Gillett, H. W. *Cupola Hot-Metal Duplexing for the Electric Steel Foundry.* Metals and Alloys, vol. 7, Dec., 1936, pp. 301-308.

[10]Hall, J. H. The Steel Foundry, McGraw-Hill Publishing Co., New York, 1914, p. 188.

Table 1

Mechanical Properties of Iron Containing T.C. 2.98, Si. 1.79, Mn. 0.63, P. 0.042, S. 0.084, Obtained by Mill Scale Oxidation of an Initial 3.34 C, 0.21 Si, 0.22 Mn. Iron. Final Additions of 1.75 Si. 0.50 Mn.

MECHANICAL PROPERTIES OF HEAT 5003

Poured From Ladle No.	Size of Bar In.	Transverse Test Corrected Breaking Load—Lb.	Corrected Deflection In.	Tensile Strength Lb. per Sq. In.	Brinell Hardness At Center	Brinell Hardness Midway Between Center & Outside	Impact 6 In. Span Ft. Lb.
		1,765	0.194	50,200			
1	⅞	1,820	0.200	48,000	217		
		3,300	0.376	46,800			49.5
1	1.2	3,020	0.362	44,600	217	214	53.0
1	2	10,920	0.397	40,600			
				36,200	204	207	
		1,760	0.183	50,000			
2	⅞	1,690	0.174	46,750	214		
		2,890	0.325	44,800			48.0
2	1.2	2,980	0.356	43,500	207	207	54.0
		9,750	0.413	41,900			
2	2	9,800	0.422	39,600	207	207	
		1,630	0.164	46,500			
3	⅞	1,650	0.163	47,000	220		
		2,770	0.298	44,000			46.0
3	1.2	2,755	0.301	44,250	201	204	48.0
		9,900	0.424	40,300			
3	2	10,320	0.410	39,400	199	197	

NOTE—Ladle 1 was poured just after the silicon addition; ladle 2, five minutes after silicon addition, and ladle 3, ten minutes after the silicon addition.

after holding 5 minutes and a third after 10 minutes, because from the work of Crosby and Herzig[11], and other similar data, there was fear that the addition of all the silicon to the ladle would not be effective. In all cases, the metal was poured at 2600°F. into ⅞ in., 1.2 and 2 in. test bars. The mechanical properties are shown in Table 1 and Fig. 2. All bars were sound. Fig. 1 shows the structure. The only difference from other irons of similar structure and composition was that the fracture was a bit more shiny and more nearly black instead of the usual gray which is probably ascribable to the nice arrangement of the graphite flakes. With all 1.2 in. bars running between 43,500 and 46,800 tensile and the 2 in. bars between 36,200 and 41,900, as shown in Fig. 2 and Table 1, and with the structure as shown in Fig. 1, it is clear that this heat is the desired Class 40 high-strength iron and that the silicon addition behaved all right, with ample time for pouring. Thus, reduction of carbon by solid iron oxide has possibilities.

It is fundamental in the oxidation of pig iron to steel or to some intermediate carbon content, that at the temperature of cupola metal, the silicon and manganese have to be removed quite completely before the carbon is attacked. That is, the more readily oxidizable silicon and manganese protect the carbon.

Handling, in this way, an initially soft iron, higher in both carbon and silicon than is desired, so as first to remove most of the silicon, and then the desired amount of carbon, is therefore not feasible. Oxidation of silicon only, followed by dilution of the melt with molten steel may, however, be resorted to. Initial adjustment of the charge to give the desired silicon, followed by duplexing in the electric where a 10 per cent steel addition is made for dilution, has been described for malleable and high-strength iron by Morrison[12], by Bremer[13] and by Moore[14]. Their requirements for added heat over that of the incoming cupola charge range from 55 to 110 kwh/ton, so something of this order must be added in non-electric practice.

At first sight this seems a tough nut to crack. However, there is a way to crack it. We are all familiar with thermit welding, and thermit steel could conceivably be used. Actually, aluminum is rather expensive fuel, and an excess of aluminum carried into the iron might not be healthy for it. Udy, of the Chromium Mining and Smelting Corporation, has proposed the use of silicon thermit, since an excess of silicon left over from the reaction is compatible

[11]Crosby, V. A., and Herzig, A. J. *Late Silicon Additions to Cast Iron.* Foundry, vol. 66, Jan., 1938, pp. 28-29, 73.

[12]Morrison, C. *Duplexing of Malleable Cast Iron.* Iron Age, vol. 133, June 7, 1934, pp. 19, 76, 80.

[13]Bremer, E. *Superheats and Refines Gray Cast Iron.* Foundry, vol. 64, 1936, pp. 26-27, 67.

[14]Moore, W. E. *The Electric Furnace in the Cast Iron Industry.* Transactions, Electrochemical Society, vol. 61, 1932, pp. 193-201.

Fig. 1—Photomicrograph of Cast Iron With Properties Listed in Table 1.

with cast iron, and such an addition can be allowed for. This material is being studied at Battelle. Instead of using iron oxide and aluminum as the heat-generating agents, as is done in alumino-thermics, sodium nitrate and ferrosilicon are used. Just as in the converter, silicon is oxidized before the iron, forming silica which is fluxed by the sodium oxide from the nitrate. If desired some lime may be added as a further flux. The reaction generates enough heat to melt cast iron chips or steel clippings almost instantaneously. The iron of the ferrosilicon plus that in the chips or clippings is thus supplied molten and at a high temperature. The mixture of nitrate, ferrosilicon and metal to be melted is termed "Fer X."

This method can be seen to be a sensible one if one recalls the heat of oxidation of silicon. About 0.08 lb. of silicon is required to produce 1 lb. hot molten steel. The heat of combustion of that amount of silicon is equivalent to about 0.215 kwh. Therefore, if we add 200 lb. of iron from Fer X to 1800 lb. molten cast iron, in the process we generate heat equivalent to 43 kwh, but since the heat is generated in place and almost instantaneously, the efficiency will be higher than that of the utilization of an equal number of kwh. in the electric furnace, and the Fer X addition should be as effective as the use of 75 kwh. in an electric furnace. If the Fer X is added in a heated forehearth, its action should be approximately equivalent to that of the usual electric duplexing method of dilution with cold steel.

A Ladle Addition of Temperature

Until chemists solved the problem of nitrogen fixation so that the price of sodium nitrate came down, it would have been uneconomic to attempt to exploit this reaction. Under present conditions it affords a means of making what we might term "a ladle addition of temperature," if the melt it produces is calculated for the same composition as the melt to which it is added, or simultaneously, of temperature and a low carbon melt for dilution. The silicon of the dilution addition can be kept low, or the desired final addition of silicon can be made simultaneously in the molten state by adjusting the Fer X composition to have excess silicon. A trial of this method gave the following results:

A Trial Heat

A hundred pound heat consisting of ¾ briquetted borings, ¼ heavy scrap was melted down in the basic induction furnace to a calculated composition of 3.35 per cent carbon, 2.30 per cent silicon, 0.70 per cent manganese, 0.10 per cent sulphur, 0.18 per cent phosphorus. It was treated with 1 lb. soda ash and the slag removed. Mill scale was then added, calculated to reduce silicon to 1.65 per cent slag removed. Fer X was then added for dilution of carbon and silicon to 3 per cent carbon, 1.50 per cent silicon, and a final inoculating addition of 0.25 per cent silicon as ferro was made. After holding 3 minutes, a set of ⅞, 1.2 and 2 in. test bars was poured, and after 10 minutes more, another set of 1.2 in. bars was poured. The metal was kept at 2850° to 2650°F. during the half hour used in applying the various treatments by the application of power as needed. Both ladles were poured at 2550°F.

The finished iron analyzed 2.96 per cent carbon, 1.73 per cent silicon, 0.55 per cent manganese, 0.03 per cent sulphur and 0.18 per cent phosphorus. The properties are shown in Table 2.

Structure and Properties Obtained

The structure of the metal from the first ladle is shown in Fig. 3. The fracture of this metal was normal. That from the second showed a trace of a tendency toward modification, but the mechanical properties show the second ladle still high-strength iron, so that pouring time should be ample.

The four 1.2 in. bars from this heat ran between the close limits of 45,500 and 47,200 tensile, averaging about 46,500. The requirement of 40,000 lb. iron has been exceeded, starting with a soft iron melt that was ¾ briquetted borings. The test does not prove that cupola metal and a heated forehearth would be as easy to handle, but it does indicate that the chemistry of the process does work. A suitable heated forehearth would have to be designed. It will also be necessary to work out chill tests or other rapid tests by which the composition can be checked at various stages in the process, until the procedure has become routine. In a first attempt we overdid the oreing down and dilution, and wound up with metal of 2.44 carbon, 1.56 silicon which was white in the second ladle poured. Correcting our aim by the experience on the first shot, we hit

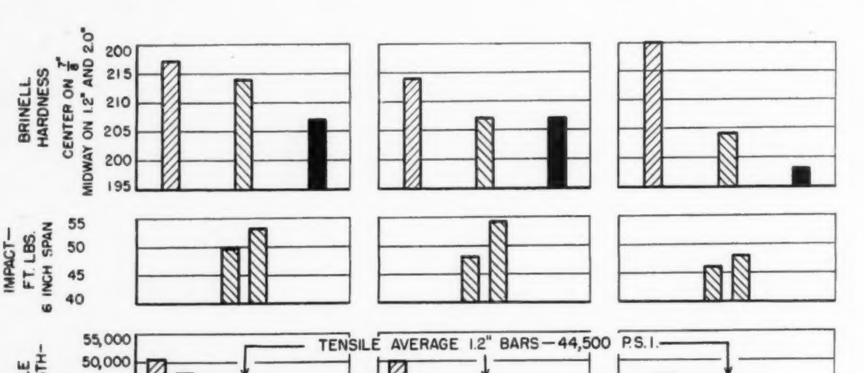


Fig. 2—Mechanical Properties of Irons Shown in Table 1.

Table 2

Mechanical Properties of Iron Containing T.C. 2.96, Si 1.73, Mn 0.55, P 0.18, S 0.03 Obtained by Soda Ash, Mill Scale and Fer-X Treatment of an Initial 3.35 C, 2.30 Si, 0.70 Mn, 0.18 P, 0.10 S Iron, With Final Addition of 0.25% Si.

MECHANICAL PROPERTIES OF HEAT 5362

Poured From Ladle No.	Size of Bar In.	Tranverse Test Corrected Breaking Load—Lb.	Corrected Deflection In.	Tensile Strength Lbs. Per Sq. In.	Brinell Hardness At Center	Brinell Hardness Midway Between Center & Outside
1	⅞	1,600	0.160	51,150	241	
				51,200		
1	1.2	2,880	0.228	47,100	223	
		2,970	0.260	47,200	223	
1	2	10,550	0.301	39,800	207	217
				43,100		
		2,620	0.193	45,500	232	
2	1.2	2,660	0.210	46,000	232	

NOTE—Ladle 1 was poured three minutes after the silicon addition; ladle 2, after a further 10 minutes.

the bird with the second barrel. There seems to be no reason why one could not make pearlitic malleable and even regular malleable from soft iron by these reactions. The next question is whether it is worth while to make high-strength or special irons in either of the two ways outlined.

Cost of Method

Since the tests indicate that the methods suggested are not entirely impractical, we may go on to consider how much it would cost to make high-strength iron in such ways.

It would be nice if one could set a definite figure for the cost of ordinary soft cupola iron in the ladle as a basis of comparison. Actually, this varies greatly with the charge and the cost of the charge varies greatly with the location and the date. In this connection, let's digress briefly to consider some possibilities of savings by selection of the cupola charge.

We all know old timers who made money on brass and aluminum castings, not because they were outstanding in their molding practice nor because they were better salesmen than their fellows, but primarily because they were skilled in utilizing scrap and in handling their melting practice. The one point in which their cost ran under the other fellow's was the cost of the molten metal before it went into the molds.

Shrewd purchase of scrap, taking back from their own customers borings whose composition is known, intelligent mixing of the metals with adequate chemical control, or use of secondary ingot into whose preparation these factors have entered, cut a big slice off the cost of the charge. When aluminum borings are run down into ingot and the aluminum content goes down and the alloy content up, the foundryman "sweetens" the ingot with sheet clippings. Use of electric furnaces where avoidance of oxidation and volatilization losses made it thoroughly economical to do so, or in the case of some bearing metals, of cupola melting when volatilization was no problem, or where it even allowed the use of zinc-containing scrap that could be bought cheaper than zinc-free scrap, made another saving. When one is dealing with materials as expensive as copper-base and aluminum-base alloys, these savings are not neglected, any neglect sticks out like a sore thumb and is likely to result in a change of superintendents.

The refiner of secondary metals has taken a good deal of the burden off the shoulders of the non-ferrous superintendent, but it is rare indeed that an analogous service is rendered in supplying pedigreed scrap for cupola charges. Yet possibilities exist for analogous savings so far realized in electric melting, but not widely realized for other melting media.

Since the electric furnace operates under non-oxidizing conditions, iron chips or steel turnings or sheet clippings can be employed, either as part of the charge in a cold melt or as an addition in duplexing hot metal in the electric. Loose borings are not good charge material for any fuel-fired furnace, and it is the ability to use cheaper raw materials than other furnaces that gives the electric an economic advantage to offset the higher cost of electric heat. Loose borings are even less usable in the cupola than in the other fuel-fired furnaces; they not only oxidize, but they clog the draft.

Borings Briquetted

Nevertheless, clean, unrusted borings, if solidly briquetted under heavy enough pressure, stay together in the cupola and melt down like pieces of solid scrap. If they are only loosely pressed, briquettes disintegrate in the cupola and are as troublesome as

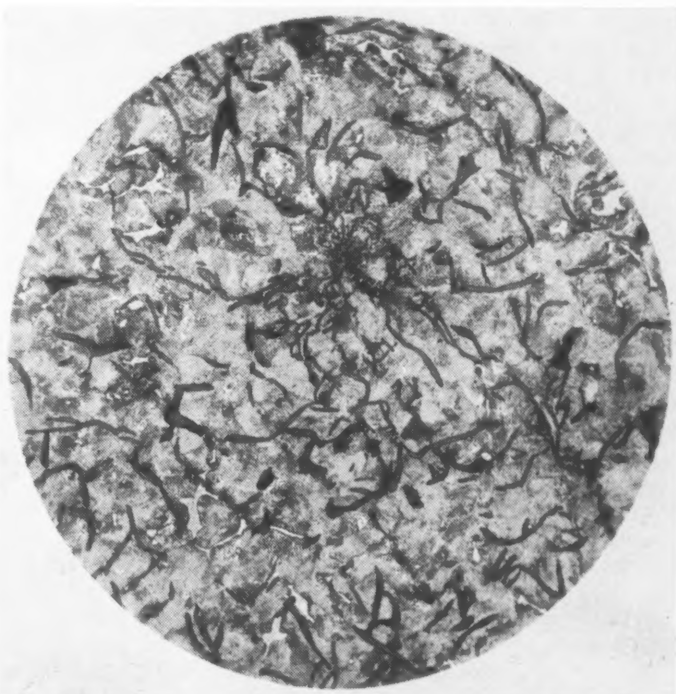


Fig. 3—Photomicrograph of Cast Iron With Properties Listed in Table 2.

Table 3

Daily Metal Trade Figures for Prices Per Gross Ton Delivered to Consumers, Chicago District.

	Sept.	Borings	No. 1 Cast	Spread	Turnings	No. 1 Steel	Spread
Average	1939	$ 8.95	$14.71	$5.76	$8.95	$16.07	$7.12
Average	1938	5.78	12.02	6.24	6.27	12.53	6.26
Average	1937	10.49	15.29	4.80	9.81	17.21	7.40
Average	1936	7.75	13.26	5.51	7.50	14.72	7.22
Average	1935	6.04	10.74	4.70	6.22	11.53	5.31
Average	1934	6.18	9.07	2.89	5.93	10.18	4.25
Average	1933	4.92	8.21	3.29	4.73	8.02	3.29
Average	1932	3.75	6.83	3.08	3.03	6.03	3.00

loose chips are. This is no new doctrine. Rayner[15] discussed the advantages of high-pressure briquetting before the A.F.A. in 1930, stating that, including overhead and amortization, he briquetted borings for $3.25 per ton, using a $60,000 press. In discussion, Walls said he had done it for $1.91 a ton. Producers of briquetting presses claim it can be done with steady operation for $1.50 on cast iron borings and under $2.00 on steel turnings. One user is said to have made savings equal to the cost of the press in eight months. From user experience, it appears that $2.00 on borings is a fair figure.

The first cost of the press, some $40,000, requires that the press be kept busy in order to amortize that cost, and the small jobbing shop obviously can't put up the money for such an expenditure. But why doesn't some enterprising scrap dealer put in a press, collect borings or turnings right at the machines in the machine shop where they are produced, apply suitable precautions against rusting so that the composition of a given lot is known, and the borings are kept unrusted, take them to the press, briquet them, and then sell you these pedigreed briquettes of cast iron or steel at a price that will give him a profit and make you a real saving over heavy cast scrap or steel rails? Or, why don't a few foundries get together and operate a press to serve the whole group? Consider Table 3:

Scrap Versus Borings

It will be noted that even in the deepest of depression when heavy scrap is almost given away, borings and turnings are also at a very low level, but the spread is even then of the same order as the briquetting cost which may be taken as $2.00 gross ton on borings—$2.25 gross ton on turnings. As times get better, the levels rise and the spread increases to two or three times the briquetting cost.

We might take the Chicago 1937 and 1938 averages as more or less representative, in 1937 of a relatively good, active year, and 1938 as of a pretty bad one.

When a preliminary draft of this talk was made early in June, pig iron, short rails, cast iron scrap, cast iron borings and steel turnings all had nine months of almost complete price stability. One could apparently figure costs with some assurance that they meant something. The events of the fall turned this all topsy-turvy, so that at any one production center the cost ratios of the various raw materials fluctuated wildly. In different localities, the spread between borings and turnings and heavy scrap was variously affected. For example, November 7 quotations were as given in Table 4.

Such figures make one wonder why everyone is not doing what a few are doing successfully in the use of briquetted borings for soft iron. Briquetted steel turnings instead of short rails for a high steel cupola charge offer equal or greater opportunity for savings.

It would appear that with the use of briquetted chips or turnings, the average cost of cupola-melted molten soft iron or of a high steel charge in the ladle in the Chicago district might have been under $13.00 per ton in 1938 and around $15.00 to $16.00 in 1937, including raw materials and cupola conversion costs. One might use such figures as more or less representative, attainable base line costs from which to calculate the cost of high-strength iron. But instead of calculating on the basis of a fluctuating base line, let's confine ourselves to figuring how much it should cost to convert cupola metal of some specific composition into a high-strength composition. In other words, whatever your cost of soft iron in the ladle is, let us try to approximate how many dollars per ton you must add to that cost when making a 40,000 lb. iron.

Case A—Alloy Iron

Soft iron, alloyed from a normal charge, with a 25 per cent steel addition to cut the silicon to the desired point, would come out about 3.35 per cent carbon, 1.65 per cent silicon. This could be made into high-strength iron by final ladle inoculation with 0.25 per cent silicon and the addition of suitable alloys. The carbon is too high, alloy salesmen would probably prefer to knock it down as near 3.00 per cent as possible to make their alloy show best results. But if you do have to shift this iron into high-strength iron, it should do the trick to add to 1919 lb. of it:

16 lb. 50 per cent ferrosilicon for inoculation	$0.60
24 lb. 50 per cent ferrochromium (high carbon)	1.25
30 lb. copper	3.50
10 lb. nickel silicon shot	3.40
	$8.75

to give an iron of 3.3 per cent carbon, 1.9 per cent silicon, 0.6 per cent chromium, 1.5 per cent copper, 0.5 per cent nickel or to 1967 lb.:

16 lb. 50 per cent ferrosilicon	$0.60
17 lb. 60 per cent ferromolybdenum	8.65
	$9.25

to give 3.3 per cent carbon, 1.9 per cent silicon, 0.5 per cent molybdenum, either of which should give 40,000 lb. iron.

Case B—Cold Electric

Making 3.00 per cent carbon, 1.50+0.25 inoculating silicon high-strength iron by cold electric melting without alloying allows the use of large proportions of chips and turnings, but, since these can be briquetted for cupola use, all we can credit the electric with on raw materials is the cost of briquetting.

Credits

Avoidance of briquetting on about 75 per cent of the charge	$1.50
Avoidance of cupola melting	2.65
	$4.15
550 kwh at 1.1c	$6.05
Equal charge for labor, electrodes, refractories, amortization, etc.	6.05
Iron silicon for inoculation	.35
	$12.45
Less credits	4.15
	$ 8.30

Table 4

	C. I. Borings	Cast Mach.—Scrap	Spread Per Gross Ton
Detroit[x]	$ 9.50	$18.00[xx]	$ 8.50
St. Louis[x]	7.00	19.00	12.00
New York[x]	8.00	16.50	6.50
Chicago	10.50	17.00[xxx]	6.50
Buffalo	11.50	20.00	8.50

[x]Brokers' buying prices—Others, prices to consumers.
[xx]Quoted as $16.50 net ton.
[xxx]Quoted as $15.50 net ton.

[15]Rayner, H. *Briquetting Cast Iron Borings for Use in the Cupola.* Transactions, American Foundrymen's Association, vol. 38, 1930, pp. 460-466.

Case C—Electric Duplexing

With an electric furnace, one could duplex a cupola melt of nearly all steel (preferably briquetted turnings), plus silvery pig for silicon, coming out at 3.30 per cent carbon, 1.50 per cent silicon, by dilution of 1800 lb. with 200 lb. loose steel turnings, with the use of about 75 kwh. and an inoculating addition of 0.25 per cent silicon plus a little manganese to correct for low manganese in the steel. 250 lb. silvery pig in cupola charge at an assumed ¾ cents per lb. over cost of regular iron.

Excess for silvery pig	$1.85
10 lb. ferromanganese	.40
10 lb. ferrosilicon for inoculation	.35
75 kwh at 1.3c kwh (relatively intermittent operation)	1.00
Plus an equal amount for labor in electric stage, electrodes, refractories, amortization, etc.	1.00
	$4.60
Less credit for avoidance of cupola melting of 200 lb. of 25c and less credit for avoidance briquetting of 200 lb. of 20c	.45
	$4.15

Case D—Fer X Dilution

If we have no electric furnace, this dilution can be made by 200 lbs. iron from Fer X which we will assume costs 1½ cents per lb. of molten iron produced over the value of steel turnings, or $3.00.

Excess for silvery pig	$1.85
10 lb. ferromanganese	.40
10 lb. ferrosilicon	.35
Excess over value of iron, 200 lbs. Fer X	3.00
	$5.60
Less credits for avoidance of cupola melting and briquetting 200 lb.	.45
	$5.15

Turn now to the cases of adjustment of carbon and silicon.

Case E

If a 3.30 per cent carbon, 0.20 per cent silicon melt is made from an all steel charge in the cupola, and about 1900 lb. of this is adjusted to 3.00 per cent carbon, no silicon, by oxidation, and the 1.75 per cent silicon added at the end, the costs of the transformation to high-strength iron figure:

40 lb. preheated ore or mill scale	$0.15
Use of heated basic forehearth, labor, amortization, etc.	1.00
15 lb. ferromanganese	.60
62 lb. ferrosilicon	2.25
	$4.00
Less for avoidance of cupola melting of 90 lb.	.10
	$3.90

Case F

If, instead of producing a special cupola melt to adjust silicon (as in cases C, D, and E) we use everyday soft iron of 3.40 carbon, 2.20 silicon and accomplish adjustment of composition wholly outside the cupola, to 1750 lb. of this melt, we may add, in a heated basic forehearth 25 lbs. preheated ore, making the composition 3.40 carbon, 1.70 silicon. To this we add 230 lb. iron from Fer X, and finish with 10 lb. ferrosilicon.

The costs figure out:

25 lb. preheated ore	$0.10
Use of heated basic forehearth	1.00
230 lb. iron from Fer X at 1½c over value of iron	3.45
10 lb. ferrosilicon	.35
	$4.90
Less credit avoidance of cupola melt on 250 lb.	.30
	$4.60

Summarizing, the estimated cost of 40,000 lb. iron over that of an ordinary everyday cupola melt has figured out as follows:

Case		
A	Alloying soft iron	$8.75 to $9.25
B	Cold Electric	8.30
C	Electric Dilution of High Steel Cupola Metal	4.15
D	Fer X Dilution, High Steel Cupola Melt	5.15
E	Removal of Carbon From High Steel Cupola Melt	3.90
F	Removal of Silicon From Soft Iron Dilution Fer X	4.60

Some General Considerations

The high steel charge to the cupola, whether steel scrap or briquetted turnings, will ordinarily cost a bit more than cast scrap or briquetted borings, and a little more coke will be required, which factors have not been considered in the above comparison. The cost of Fer X may have been taken a little high. The estimate of $1.00 per ton for the heated forehearth is probably generous, too. Thus, the last four methods are likely to be even in cost so that it would be hard to distinguish among them on the economic basis.

The last three methods indicate that the production of 40,000 lb. iron should be capable of accomplishment in a cupola foundry without requiring very expensive equipment and without materially altering ordinary cupola practice for ¼ cent per lb. of metal in the ladle over the cost of soft iron. The 40,000 lb. iron will be a proper base for efficient alloying to still higher strength irons.

The last three methods look interesting for foundries in the transition period while the demand for 40,000 lb. iron is yet not sufficient to allow its steady production. When really steady production is assured, either electric duplexing, or the assignment of a cupola and a gang to the steady production of 3 per cent carbon iron direct from the cupola, would be resorted to.

A little special equipment will be necessary in using these methods. Naturally, hot-blast cupolas will be helpful in holding the temperature up. Every precaution to secure uniformity in the performance of the cupola must, of course, be taken, and the development of instruments and control methods to facilitate uniformity is an extremely worth-while task, one that will justify research. Hot-blast cupolas are not out of reach of the small foundry, since MacKenzie[16] has described a simple type and the Griffin cupola, described by Fiske[17] will, it is understood, be installed and allowed to pay for itself out of the coke saving it brings over previous cold-blast practice.

Forehearth Use

A heated forehearth will be needed, preferably one into which the metal flows constantly and is thus more promptly removed from contact with coke since every point of carbon we can avoid picking up is a gain. Possibly even the provision of two tapping spouts and two such forehearths may be called for, so that metal may be allowed to accumulate alternately in each for mixing and to give time for soda-ash treatment, when required, for taking chill test samples by which next steps of treatment and the final silicon addition are determined, and where these steps and additions, plus any needed alloy addition, may be made in unhurried fashion. (Development of suitable rapid tests is an important factor in control.)

The soda-ash treatment and the removal of silicon by oxidation are best carried out on a basic lining; so the forehearths should be basic lined and suitable provision made for slag disposal. Such forehearths would conveniently be made tilting. Firing would probably be by gas or oil.

The complete design of such forehearths would depend on the desired capacity, the particular process steps selected, and the heat input thereby required to bring the metal to the ladle at the proper temperature. This is another specific research problem, but there is nothing about it to require a very high installation cost.

In oxidizing carbon or silicon with ore or mill scale, it may be desirable to preheat the ore in some simple heating furnace.

There seems to be nothing fundamentally difficult about the practical application of the methods suggested. They need further development before one can appraise them exactly, but so far they look feasible, both technically and economically. They are suggested as deserving the further research that will make them practical accomplishments.

[16] MacKenzie, J. T. *The Moore Hot-Blast Cupola.* Transactions, American Foundrymen's Association, vol. 39, 1931, pp. 197-203.

[17] Fiske, R. A. *Iron Refined by Griffin Duplex Process.* Iron Age, vol. 134, Sept. 27, 1934, pp. 13-17.

New Members

Company Members

American Steel Castings Co., Newark, N. J. (Karl V. Wheeler, Vice Pres.)

Joseph Behr & Sons, Inc., Rockford, Ill. (I. Joseph Behr, Jr., Pres.)

Grayson Heat Control, Ltd., Lynwood, Calif. (Delbert A. Luper, Foundry Supt.)

Ottumwa Iron Works, Ottumwa, Iowa (D. J. Neasham, Vice Pres. & Wks. Mgr.)

Racine Foundry & Mfg. Co., Detroit, Mich. (James B. Anderson, Gen. Mgr.)

Personal Members

Mrs. R. E. Barnes, Saulsbury Sand Co., Chattanooga, Tenn.

L. C. Beers, Claude B. Schneible Co., Chicago, Ill.

R. G. Cadwell, Secretary, Spuck Iron & Foundry Co., St. Louis, Mo.

Henry Chisholm, Jr., Salesman, Republic Steel Corp., Cincinnati, O.

H. L. Comin, Plant Mgr., Indiana Gas & Chemical Corp., Terre Haute, Ind.

S. F. Cromwell, Electric Steel Castings Co., Indianapolis, Ind.

George F. Haislup, Electric Steel Castings Co., Indianapolis, Ind.

Wm. Harlan, Supt., Ben Sibbitt Iron & Foundry Co., Wichita, Kans.

Thomas R. Herron, Gen. Fdry. Foreman, American Locomotive Co., Schenectady, N. Y.

Arthur K. Higgins, Metallurgist, Allis Chalmers Manufacturing Co., West Allis, Wis.

W. G. Jones, Foundry Engr., R. Lavin & Sons, Inc., Chicago, Ill.

Arthur S. Klopf, Fdy, Supervisor, Kearney & Trecker Corp., West Allis, Wis.

Robert Latham, Supt., Iron Fdy., Bethlehem Steel Co., Bethlehem, Penna.

Ben J. Lippert, Dist. Mgr., Federated Metals Div., American Smelting & Ref. Co., Cincinnati, O.

V. T. Malcolm, Met. Engr., Chapman Valve Mfg. Co., Indian Orchard, Mass.

Earl Mattox, Electric Steel Castings Co., Indianapolis, Ind.

A. J. Mulvihill, Vice Pres., Hannibal-Car Wheel & Fdry. Co., Hannibal, Mo.

Ralph C. Noah, Mgr. San Francisco Stove Works, San Francisco, Calif.

W. G. Probst, Jr., Supt., Knowles Foundry & Machine Co., Ottawa, Ill.

J. F. Quest, Pres., Jeffery Quest Foundry Co., Minneapolis, Minn.

Leo R. Rice, Pattern Shop Ass't. Foreman, International Harvester Co., Indianapolis, Ind.

Frank M. Robbins, Jr., Purchasing Agent, Ross-Meehan Foundries, Chattanooga, Tenn.

Henry H. Smith, York, Pa.

D. E. Stephens, Salesman, H. Kramer & Co., Milwaukee, Wis.

H. S. Taylor, Branch Mgr., Frederic B. Stevens, Inc., Indianapolis, Ind.

R. A. Thompson, Electric Steel Castings Co., Indianapolis, Ind.

E. S. Todd, Metallurgist, Kinney Iron Works, Los Angeles, Calif.

Wm. Russell Weir, Foreman, Dominion Foundries & Steel, Ltd., Hamilton, Ontario, Canada.

Arlan Wentzel, Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.

Foreign

George B. W. Holdship, Managing Director, The Victor Motor Co. Pty., Ltd., Alexandria, Sidney, Australia.

Review

Fine - Grained Molding Sand Resources of Northern Illinois, by H. B. Wilman, Illinois State Geological Survey, Report of Investigations, No. 57, pp. 1-53, 1939. (Review by Dr. H. Ries, Technical Director, A.F.A. Foundry Sand Research Committee.)

Since large quantities of fine-grained molding sand are used annually in the Chicago area, and much of this is obtained from the Albany, New York, district, the Geological Survey has made an investigation to determine whether or not similar materials could be obtained in Illinois. The present report gives the results of investigations carried on in Northern Illinois.

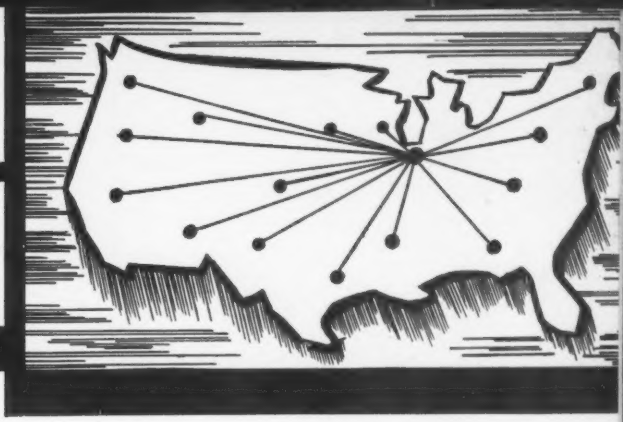
For this purpose a number of deposits were examined and samples collected for testing. These were submitted to fineness tests, as well as to those for permeability and green compression at different moisture contents. In addition, the Illinois sands also were compared with those from the Albany, New York, and Southern Indiana districts for mineral content.

The report lists a number of localities where promising sands were found, but points out that more testing should be done to determine their extent.

The deposits most likely to be of suitable character were found in Cook, Henry, Jo Daviess, Mason, Rock Island and Whiteside counties.

It is suggested that while some of the Illinois sands could probably be used in their natural condition, others could be improved by blending.

Chapter Activities



Central Indiana Organizing as 18th Chapter

FURTHER evidence of the interest of members in the chapter movement was indicated when on October 30 some 125 members and guests gathered together at the Columbia Club, Indianapolis. The meeting had been called by the Association on the request of a number of members in the Central Indiana territory who wished to propose a chapter organization. The attendance represented foundries from some nine cities in the Central Indiana area, including, in addition to Indianapolis, Muncie, Kokomo, Anderson, Newcastle, Terre Haute, Connersville, Richmond and Marion.

I. R. Wagner, vice president, Electric Steel Casting Company, acting as chairman, opened the meeting with a statement of its purpose. He then called upon R. E. Kennedy, secretary, A.F.A., who explained how chapters were organized and functioned and gave a short history of A.F.A. activities. The chairman then introduced A. W. Gregg, Whiting Corporation, Harvey, Ill. Mr. Gregg, who has been an active worker in the Chicago Chapter, presented information on how a chapter can benefit its members through many educational projects.

After these preliminaries, Mr. Wagner introduced H. W. Dietert, president, Harry W. Dietert Company, Detroit. Mr. Dietert gave a highly instructive illustrated address on "Fundamentals of Foundry Sand Control," the talk being followed by a lively question and answer period.

As a large number of those present signed petition cards for a formal organization meeting, this is being called for December 4, at which time a nominating committee will present for election a slate of officers and directors. The technical speaker of the evening will be W. R. Jennings, John Deere Tractor Company, Waterloo, Iowa, who will discuss some molding production methods.

Ontario Chapter Learns About Air Brake Castings

By G. L. White*, Toronto, Ont., Canada

THE first regular meeting for the 1939-40 season of the Ontario Chapter found some one hundred and twenty-five members and guests in attendance at the Rock Garden Lodge, Hamilton, on October 7. Chairman D. J. MacDonald, Dominion Radiator and Boiler Co., Ltd., Toronto, presided over a program which included special entertainment provided by the entertainment committee and an excellent short symposium on the production of air brake castings under the leadership of John Reid, superintendent of foundries, Canadian Westinghouse Co., Ltd., Hamilton.

Following a brief introduction of the subject, Mr. Reid presented four members of his staff—pattern maker, core maker, molder and inspector—who, in turn, described their own particular share in the production of air brake castings, while placing emphasis upon the inter-departmental cooperation that is so essential to the most efficient foundry production.

The spirit of cooperation, so well developed in the foundry itself, goes beyond the foundry and extends to the engineering department, which exercises every care in the design of castings; and to the machine shop, which endeavors to keep its requirements upon the foundry reasonable if strict. When the requirements for a new casting come in from the engineering department, the chief pattern maker and members of the foundry staff discuss the whole problem thoroughly before the layout is made. Careful attention to layouts simplifies all succeeding operations and complete knowledge of the job in hand enables the pattern maker to save upon inconsequential details whose importance he could not judge properly if working from a drawing alone.

Production of a pattern is followed by the making of a sample casting, which is sent to the air brake engineer for inspection, carefully checked for location of centre lines, and cut up to assure the foundry that correct thicknesses exist in all sections.

Core set-up for certain air brake castings are exceedingly complex with a single set-up comprising as many as 48 individual cores. Cost of such a core set-up is considerable under the most favorable conditions and in order to keep costs within bounds and quality up to the mark, some standardization of methods is essential. On one

*Canadian Metals and Metallurgical Industries.

core set-up job ten men are employed, working to a schedule which aids greatly in the production of uniform set-up. The joints are finished off as the work proceeds and at the conclusion of the operation the cores are ready for baking and inspection. The use of a certain portion of silica flour in the core mixtures has been found superior to a wash for prevention of burning-in of the iron.

The inspector plays a very important role in the production of sound air brake castings. To carry through his job effectively, the inspector keeps in close touch with engineering, machine shop and foundry departments. The stand which must be taken by the inspection department is that the customer knows what he wants, but if his demands are unreasonable, an attempt must be made to get the customer to see the foundry's point of view. A fair attitude on the part of the inspector toward all concerned results in the willingness of the foundry to cooperate to the limit in meeting the requirements of other departments or making adjustments required to eliminate certain defects. A certain amount of inspection is carried out before machining, and after this operation castings are tested for air tightness from port to port. When persistent trouble occurs, castings may be cut partly through and broken at the point where the trouble is believed to be. By this means it is possible to analyze most of the causes encountered very quickly and arrive at satisfactory solutions.

Lane Explains Wear of Cast Iron to New York-New Jersey Chapter

By K. A. De Longe*, Bayonne, N. J.

THE "Wear of Cast Iron" was the topic of discussion at the November meeting of the Metropolitan N.Y.-N.J. Chapter, held November 6 at the Essex House, Newark, N. J. Technical Chairman R. J. Allen, Worthington Pump and Machinery Co., introduced the speaker of the evening, Paul S. Lane of the American Hammered Piston Ring Div., Koppers Co., Baltimore, Md.

A group of about eighty guests and members was present when Mr. Lane opened his talk by stating that although wear has been defined as "an undesirable change in dimension under service," there are instances in which wear is desirable, citing piston ring applications as a case in point. The hardness, strength and other common properties of cast iron give no reliable indication of its wear resistance and although microscopic examination has shed some light on the problem, the safest method of determining whether or not a particular iron will give satisfactory wear performance is to actually subject it to a wear test.

Data obtained from tests conducted in the speaker's laboratory have established certain fundamental requisites for good wear resistance. Graphite form and distribution are vital considerations, said Mr. Lane. Dendritic type graphite with associated free ferrite is certain to produce scuffing while normally distributed fine flake graphite generally gives best results. The presence of moderate amounts of phosphorus as steadite and sulfur as manganese sulfide has proved to be beneficial to the wear resistance, probably because the introduction of added phases tends to confer upon the iron the qualities of bearing metals. Although small quantities of free carbide may be helpful, for the same reason, large proportions produce scoring.

Mr. Lane presented data to show that heat treatment will reduce the weight loss of cast iron but at the same time increase scuffing of the other wearing surface. In many instances, combinations of alloys have had a beneficial effect on wear performance. Alloying to high hardnesses, however, produces much the same effect as heat treating in that the wear loss is reduced but scuffing is increased. In the final analysis, the problem of securing satisfactory wear resistance is one of compromising the weight loss of the iron with its scoring or scuffing effect on the other wearing surface. A discussion centering on the technique of wear testing followed the excellent talk.

Earlier in the evening, the dinner guests were treated to an excellent coffee talk on snakes and their habits with speaker, R. W. Thorne of Bennett Insured Steel Treating Company fascinating his audience by displaying a collection of live reptiles.

Chapter Chairman W. E. Day, Jr., announced K. V. Wheeler, vice-president of the American Steel Castings Co., as the speaker for the December 4 meeting. His subject will be "How Design Factors Affect Steel Castings."

*International Nickel Co. Research Laboratory.

Purchasing Castings and Foundry Coke

By Pat Dwyer*, Cleveland, O.

AT THE November meeting of the Northeastern Ohio Chapter, A.F.A., held at the Tudor Arms, Cleveland, November 9, approximately 120 members and guests heard a witty and informative talk on selling castings by Art Hopcraft, purchasing agent, Cleveland Worm & Gear Co., Cleveland, and a practical talk on foundry coke by B. P. Mulcahy, research engineer, Citizens Gas and Coke Utility, Indianapolis, Ind. Drawing from his long years of experience as a purchasing agent, Mr. Hopcraft touched upon the science of selling from many angles, all pointing to the con-

*Engineering Editor, *The Foundry*.

L. D. Wright
Secretary
Central New York

M. J. Carpenter
Treasurer
Wisconsin

L. L. Henkel
Secretary
Chicago

H. K. Ewig
Chairman
Cincinnati

clusion that the most essential features in modern selling—outside, of course, of a thorough knowledge of the product—are originality and the practice of psychology. Drawing in a similar manner on his memory, imagination and fertility of expression, he illustrated the many points of his talk by a series of anecdotes, modern streamlined and highly improved versions of incidents in the field cultivated in a scholarly and interesting manner many years ago by the late M. Rabelais and M. Maupassant.

Mr. Mulcahy's paper embraced a rather comprehensive scrutiny of all factors in connection with melting iron in the cupola, and was not limited to the fuel alone. As a preliminary feature, he presented an illustrated description of the principal items in the manufacture of coke and then took up the subject of the many factors affecting iron quality under four general heads: The cupola, the raw metal, the air, the coke. Pointing to the almost limitless variations in detail, the speaker instanced the following factors encountered in an attempt to standardize certain features: Height of cupola from charging door to bottom, 8 to 30 feet, diameter 24 inches to 84 inches, charges 600 pounds to 12,000 pounds, melting rate 2 to 30 tons per hour, time of heat ¾ to 24 hours per day, tuyere area per cent 7 to 63, rows of tuyeres 1 to 3, coke ratio 4:1 to 12:1, steel in charge up to 85 per cent, scrap in mixture up to 100 per cent.

The greater part of the talk was devoted to the operation of and reactions in the cupola, with particular reference to the manner in which the final result is influenced by the size, shape and other features of the coke. He cited several typical instances in which the carbon content was changed to a marked extent by changing the size of the coke. Other characteristics of coke and their effect on cupola operation were covered under the headings: Volatile matter, ash, sulphur, combustibility.

He claimed that intimate acquaintance with all points of operation are necessary on account of the existing diversity. Danger lies in interpreting results from individual plants and stating these as fundamental facts. Too often these conditions exist only under the particular circumstance in one plant. If employed elsewhere, they might lead to serious difficulty.

Don Reese Addresses Philadelphia Chapter

By J. T. Fegley*, Philadelphia, Pa.

ON November 10, the Metropolitan Philadelphia Chapter held another well attended regular monthly meeting. With over 175 present, chapter vice chairman R. J. Keeley, Ajax Metal Company, presided in the absence of chairman Hartmann. A coffee talk was given by "Capt." Dwight Long, North Bros. Mfg. Company, while the technical talk was given by Donald J. Reese, International Nickel Company, New York City. Announcement was made that the chapter would hold a special meeting November 27, this to be known as "President's Night," in honor of the national President, Henry S. Washburn, with Dr. M. M. Dorizas, University of Pennsylvania, speaking on "The Present European Situation."

"Capt." Dwight Long thrilled his audience with colored motion pictures as he told of his accomplishment of sailing 35,000 miles—three-quarters around the globe from Seattle, Wash., to New York harbor in four years in a 32-foot ketch. He visited Hawaii, Tahiti, Samoa, Australia, Papua, Singapore, Bay of Bengal, Arabian Sea, Red Sea, Mediterranean Sea, Spain, England, and back to America. He plans to complete his trip back to Seattle within the next month and fulfill his ambition to sail around the world.

In his talk on "Cupola Practice," Donald J. Reese briefly referred to the many phases of the subject that should be cov-

*North Bros. Mfg. Co. and Chairman, Chapter Publicity Committee.

ered in a discussion of this sort but because of the limited time available would have to be passed over in order to discuss problems of contemporary interest. Mr. Reese prefaced his talk with the statement that foundrymen were faced with the immediate possibility of being required to step up the quality levels of their cast irons and that the decreasing availability of suitable grades of steel and cast iron scrap, at present prices, made it imperative that they study the importance of the cupola melting unit in order to keep costs within reason and successfully meet specifications on higher quality.

The relationship between fuel and quality of product was discussed. Metal temperature losses between the breast opening of the cupola and the metal entering the mold could be as much as 400° F., even in a well operated foundry. It was pointed out that there are 5 distinct zones in the cupola. The three methods of tapping metal from a cupola, the reasons for slagging a cupola and the methods used to handle slag were discussed at length. The speaker stressed the importance of total carbon determinations, tensile strength values and microstructure for control factors in cupola operation. Julien Greenstreet, superintendent, Textile Machinery Company, Reading, Pa., acted as discussion leader.

Cincinnati District Chapter Holds Dayton Extension Meeting

By E. T. Korten*, Cincinnati, O.

THE Dayton extension meeting of the Cincinnati District Chapter, held November 14, at Dayton, O., was very successful, those assembled for dinner at the Hotel Biltmore numbering 167. The Dayton Foundry Club was host and all were welcomed by its chairman, Dave Finn, who introduced Dr. Arthur Marcus, known as the "Mad Magician," who had many surprises in his performance, which was enjoyed by all.

Following a short intermission, the business meeting was turned over to our chapter chairman, Herman K. Ewig, Cincinnati Milling Machine Co., who expressed his appreciation for the wonderful reception given us and told the history of our chapter, explaining the future program and inviting all those who had not yet become affiliated with us to do so in the near future. The group present represented Dayton, Piqua, Troy, Miamisburg, Springfield, Middletown, Wilmington, Hamilton, Overpeck, Zanesville, Detroit, Lancaster and Covington, and 85 members from the Cincinnati group. Three motor busses were used to convey the Cincinnati group to Dayton and an entertainer was provided for each bus. Song sheets were distributed which resulted in unusual harmony.

It was announced that the Cincinnati Chapter will hold a Christmas party and dinner dance at the "Village" in the Hotel Alms on December 15. Everyone was requested to reserve this date as the committee has promised that this affair will be the best ever arranged by our group.

*Reliable Pattern & Castings Co. and Secretary, Cincinnati District Chapter.

Dayton Extension Meeting of Cincinnati District Chapter.

Grinding Methods Considered by Southern California

By W. F. Haggman*, Los Angeles, Calif.

OVER 80 members attended the November 16 meeting of the Southern California Chapter, held at the Elks Club, Huntington Park. James Eppley, Kinney Iron Works and chapter vice-chairman, presided in the absence of Chapter Chairman Al Zima. Announcement was made of the Christmas party to be held December 15 at the Lakewood Country Club, Long Beach. A coffee talk feature was the showing of a color film, "Die Casting the Modern Way," shown through the courtesy of the Harvill Air Craft Die Casting Company. Glenn Merrefield, Warman Steel Casting Company and chairman of the apprentice committee, stated that the chapter foundry training course, gray iron division, opened November 13, with some 25 students. The steel course opened November 15, with classes being held at the Manual Arts High School. The feature of the evening was a splendid talk by Dick Hughes, Pacific Metals Company, on the history of abrasive grinding wheels. After this talk, Mr. Hughes and C. G. Emery, Macklin Company, led a general round table discussion on this subject.

*Foundry Specialties Co. and Secretary, Southern California Chapter.

Cupola Practice Birmingham Subject

By Farrar Hill*, Birmingham, Ala.

THE Birmingham Chapter continued its regular meetings on November 17 with a program devoted to a discussion of cupola practice, Donald J. Reese, International Nickel Company, New York, being the speaker of the evening. Chapter Chairman R. C. Harrell, Stockham Pipe Fittings Company, introduced C. K. Donoho, American Cast Iron Pipe Company, as technical chairman. Mr. Donoho in presenting Mr. Reese, as a national authority on cupola operation, told of his outstanding work in the education of foundrymen through his extensive lectures before chapters throughout the country.

Mr. Reese's talk, which was accompanied by illustrative slides, dealt with the several phases of the operation of a cupola, high-lighting the relationship between cupola diameters and weights and sizes of melting materials. He stressed the various functions of the coke bed, pointing out the relationship between coke and quality of the iron produced, concluding with a discussion of various tapping methods.

*Hill & Griffith Co. and Chairman, Chapter Publicity Committee.

Dietert is Speaker Before Buffalo Chapter

By J. R. Wark*, Buffalo, N. Y.

W. J. CORBETT, Atlas Steel Foundry Company and chairman of the Buffalo Chapter, presided at the regular monthly meeting of the chapter, held November 3 at the Hotel Touraine. With 90 at the dinner, the total attendance was swelled to 125 by others coming in later. The chapter was honored by having Mayor Holling address the group, following the dinner. Then J. F. Tinney, Republic Steel Corp., showed a movie of bob-sledding in the Adirondacks, wherein young Bob Tinney introduced a new type of iron runner which aided the American team to establish a new record.

The main speaker of the evening, H. W. Dietert, Harry W. Dietert Co., Detroit, was introduced by Chairman Corbett. Mr. Dietert gave an extremely interesting talk on the fundamentals of sand control in the foundry. As usual, when Mr. Dietert talks on sand, an intensive discussion period followed his presentation.

*Queen City Sand & Supply Co. and Secretary, Buffalo Chapter.

Sefing Lecture Hits the Spot

By L. D. Wright*, Geneva, N. Y.

THE Central New York Chapter feels fortunate in having secured Fred G. Sefing, metallurgist, International Nickel Company, New York, to present a series of four lectures on fundamentals of iron metallurgy. The material presented and the method used in Mr. Sefing's talks are being greatly appreciated by the chapter. The second lecture was given at the November meeting, held at the Hotel Onondago, Syracuse, on November 10. The third will be given on December 8.

During the second lecture, Mr. Sefing discussed in a particularly instructive way the effects of alloying elements on cast iron, while the first covered the effect of the more common elements, carbon, silicon, manganese sulphur and phosphorus. The third and fourth lectures will cover the practical application of the relationship and function of these elements as applied in every-day foundry practice. At each lecture a copy of the notes covering the evening talk is given to each one attending.

*Supt., U. S. Radiator Corp. and Secretary, Central New York Chapter.

Power Developments Presented Before Northern California Chapter

By Geo. L. Kennard*, San Francisco, Calif.

DEAN SAMUEL BROOKS MORRIS, builder of multiple purpose water impounding dams and reservoirs, former director of the American Water Works Association and a director of the Seismological Society of America, illustrated a one-hour talk on his experiences over many years in this all-important engineering field, concentrating on the historical features of the water flowing into the Columbia River and the natural advantages offered for controlling flood water, and by holding it against causing destructive waste, making it available for generating electrical power as well as developing vast acreage by irrigation.

To most of us, this extensive and costly preparation for mass production of power and agricultural products, seems altogether out of place in view of present conditions, but, as no one can foresee the growth and shift of population into this comparatively little developed area, future generations may be grateful for what has been and is being done to provide for their abundance of comfort and safety.

One might have thought this talk had no direct bearing on the foundry business, until mention was made of the part steel, iron and brass foundries had played in supplying the needs for specially designed castings. Acknowledgment of this interlocking cooperation of the foundry industry with this great engineering feature increased the interest beyond our first expectation.

In thanking Dean Morris for his contribution, our Chairman, Sam Russell, said that he could recommend the Dean as a fine fellow to meet and one who could tell a dam story in such a way as to glorify the engineer for his ability to do what seems at first impossible in "making the world safe for democracy," which is that for which we stand.

*Secretary-Treasurer, Northern California Chapter.

Red Letter Day for Detroit Chapter

OVER 150 members and guests attended the November 16 meeting of the Detroit Chapter. This meeting will be long remembered because of its unusual interest, for it featured a group of speakers from the Campbell, Wyant & Cannon Foundry Company, Muskegon, Mich., describing the safety and health program of this organization, a leader in the foundry industry. The meeting was opened by Chapter Chairman Harry W. Dietert, who introduced Vaughan Reid, City Pattern Works and past chapter chairman.

Mr. Reid in turn presented George Cannon, vice-president of the Campbell, Wyant & Cannon Foundry Company, who gave a general picture of the development of the health and safety program of his company, which has been a leader in employer relations. Mr. Cannon was followed by E. W. Beach and Dr. C. M. Colignon of the C.W.C. organization, who presented a comprehensively illustrated description of the safety and health program, together with complete details of the medical and employee examination building. Every step of employment department examination, sets of records used and procedure in following up employee health records was clearly described. Following the formal presentation, with Mr. Beach acting as chairman, questions were asked by the audience and answered by Mr. Beach, Dr. Colignon and William Barkley, personnel director, C.W.C. Co.

Detroit Chapter Hears Jennings on Molding Equipment

By O. E. Goudy*, Detroit, Mich.

THE Detroit Chapter held its regular monthly meeting on Thursday, October 19, at Huyler's L'Aiglon Restaurant. With a large number of members and guests in attendance, W. R. Jennings, foundry superintendent, John Deere Tractor Company, Waterloo, Iowa, formerly of Detroit and well known to many present, was introduced by the chairman, F. J. Walls, International Nickel Co.

Mr. Jennings' discussion covered the efficiency of operations, particularly as pertaining to pattern and molding equipment at the Deere plant. As to the often-asked questions, "When should a molding machine be used?" and "When should a sandslinger be used?" Mr. Jennings showed that the efficiency of each was about equal. That is, each would produce the same number of molds per man, per unit, and the choice of equipment to be used was largely dependent upon the size and shape of the castings to be made.

From an efficiency standpoint, Mr. Jennings showed that the molding unit was the key unit in the foundry, and that it was the purpose of all others to serve this unit in such a manner as to get the most possible number of good molds per unit of time. After the discussion, Mr. Jennings answered many general questions as they pertained to the Deere plant at Waterloo.

*Kelsey-Hayes Wheel Co.

Armstrong Addresses St. Louis Chapter

By J. W. Kelin*, St. Louis, Mo.

THE St. Louis District Chapter, at its November meeting held the evening of November 9 at the York Hotel, had as its principal speaker T. N. Armstrong, International Nickel Company, N. Y. Mr. Armstrong, in his talk, discussed "Welding and Flame Hardening." Developments along these lines were illustrated with many interesting stereopticon views and this talk was considered very educational and instructive. Chapter Chairman Everett introduced S. M Tiffin, recently appointed general manager, St. Louis Branch, Federated Metals Div., A. S. & R. Co. Mr. Everett also announced that the Chapter directors had voted to cooperate with the Quad City Chapter in a joint regional meeting for the fall of 1940 and that L. J. Desparois had been appointed chairman of the committee to cooperate in arranging this meeting.

*Federated Metals Div., American Smeltir & Refining Co., and Secretary-Treasurer, S Louis Chapter.

Twin City Foundrymen Hold Two Meetings

By O. W. Potter*, Minneapolis, Minn.

THE Twin City Foundrymen's Association had its first meeting of the season at the North Central Commercial Club, St. Paul, Minn., on September 18, 1939. The guest speaker was Wm. B. George, R. Lavin & Sons, Inc., Chicago, Ill. His subject was "Brass Foundry Practice." Mr. George interspersed his talk with many examples of actual experience which had come under his observation in the many years he has been working with brass foundries.

The November meeting was held jointly with the A.S.M. on November 15, 1939, at the University of Minnesota. Dinner was served to about 100, the most of whom were foundrymen. After dinner, an open meeting was held in one of the large lounge rooms of the Minnesota Union where there were about 200 present. The guest speaker was Hyman Bornstein, director of research, Deere & Co., Moline, Ill., who talked on the subject, "Cast Iron." The lecture covered all phases of cast iron, including high test cast iron, alloyed cast iron and malleable cast iron and was illustrated with numerous slides. Following the lecture there was a round table discussion for about 30 min. which brought out further points of interest.

*University of Minnesota and Secretary, Twin City Foundrymen's Association.

New England Foundrymen's Association Studies Chilled Car Wheels

By M. A. Hosmer*, Boston, Mass.

FRANCIS LE BARRON, vice-president, New England Foundrymen's Association, presided at the Association's meeting, held November 8, Engineers' Club, Boston. With an attendance of some 75 members and guests, the group heard a most interesting talk on chilled car wheel manufacture given by T. C. Weiser, superintendent, Griffin Wheel Company, Chelsea, Mass. In connection with the talk there was shown a moving picture, "The Story of Chilled Car Wheels," presented through the courtesy of the Association of Manufacturers of Chilled Car Wheels.

Mr. Weiser told the members that with approximately 3,000,000 cars now in use and eight wheels required per car, a total of 24,000,000 wheels to keep going formed the basis of this thoroughly modern industry. The strict specifications set up for a car wheel have made this process thoroughly scientific. Sand conditioning equipment, research departments and chemical control are required of the successful car wheel manufacturer.

The chilled tread is formed by a chiller in each mold. This is used only once per day and its life is approximately 200 wheels. Care must be exercised in cleaning these chillers thoroughly before using again. A hard brush is usually employed and the surface carefully inspected before the paste is applied. The chill is about $4\frac{1}{2}$ inches thick and remains in contact with the wheel after pouring for 38 minutes for the average size wheel of about 700 lbs. He recommends fast pouring as a requisite for eliminating chill checks in the casting. The casting is then immediately removed to the annealing oven or soaking pit.

Accurate temperature control of melting and pouring with the optical pyrometer, regular physical inspection, close chemical control, rigid physical tests under a 250-lb. drop hammer are some of the factors which are involved in the manufacture of a modern chilled car wheel, which is guaranteed for seven years and which averages better than 100,000 miles.

Previous to the address by Mr. Weiser, moving pictures were shown, through the courtesy of the New England Coke Company, of the last meeting of the Association, which was a visitation to the plant of the Mystic Iron Works.

*Chemist, Hunt-Spiller Mfg. Co.

A. J. Busch Addresses Freeport Meeting

By H. C. Winte*, Beloit, Wis.

THE November meeting of the Northern Illinois-Southern Wisconsin Chapter was held at the Hotel Freeport, Freeport, Ill. A goodly attendance of 83 members turned out for this meeting, while chapter chairman G. J. Landstrom, Sundstrand Machine Tool Company, Rockford, presided. Chairman Landstrom presented as the evening speaker, A. J. Busch, engineer with C. C. Kawin Co., Chicago. Mr. Busch took as the subject of his talk "Defective Castings—Causes and Remedies." He outlined the various causes and showed how foundry practices must be controlled to prevent these defects. Phases particularly stressed were metal mixtures, melting practices sands, molding and core making and gating and risering.

*Fairbanks Morse & Co. and Technical Secretary, Northern Illinois-Southern Wisconsin Chapter.

Front Cover

THE front cover of this issue is of special interest to members of the Association, as it illustrates the visit of officers of the Wisconsin Chapter to the plant of one of its members, the General Malleable Corporation, to inspect a recently installed annealing oven. In its endeavor to be most efficient in producing quality castings for casting buyers, the General Malleable Corporation installed a continuous annealing oven. On its installation the company, through B. D. Claffey, manager of its gray iron division and chapter vice-chairman, invited a number of the chapter officers to inspect the installation. Those shown in the picture, reading from left to right, are Mr. Claffey, T. E. Ward, Badger Malleable Co.; Charles Wesley, Wesley Steel Treating Co.; Harry Donald, Federal Foundry Supply Co.; Prof. E. R. Shorey, University of Wisconsin; oven tender; W. E. Gloede, General Malleable Corp.; Wm. J. MacNeill, Federal Malleable Corp. and chapter chairman; Walter Gerlinger, Walter Gerlinger, Inc., and past chapter chairman; and Oscar Patzke, Smith Steel Casting Co.

Institute in Foundry Methods

THE Center for Continuation Study and the Institute of Technology for the University of Minnesota, Minneapolis, are offering an institute in foundry practices to be held December 7, 8, and 9. The theme of the Institute will be "Modern Foundry Methods Necessary to Meet Casting Specifications." Attention to fundamentals of foundry practice will be stressed and such topics as cupola practice, specifications, and production of alloy castings will be presented and discussed both formally and at the popular round-table discussions.

The faculty of the Institute will consist of professors from various University staffs and engineers and technologists chosen from top ranking foundries of the country. Any foundry executive who is interested in attending this Institute should register with Fulton Holtby of the Foundry Department of the University of Minnesota.

Abstracts

Note: **The following references to articles dealing with the many phases of the foundry industry, have been prepared by the staff of *American Foundryman*, from current technical and trade publications.**

When copies of the complete articles are desired, photostat copies may be obtained from the Engineering Societies Library, 29 W. 39th Street, New York, N. Y.

Alloys

BERYLLIUM. *"Beryllium — A Versatile Element,"* by Louis L. Stott, *The Iron Age*, vol. 144, No. 12, September 21, 1939, pp. 42-45. Since this metal's discovery many years ago beryllium has developed into one of the most prominent metals of the day. This article attempts to show its true sphere of influence in today's metallurgy. Beryllium-copper alloys, beryllium-nickel alloys and light alloys of beryllium are discussed by the author. Due to its lightness aviation pays great attention to this metal but there has been no commercial use to date of the element in the light-alloy field. (A1.)

FATIGUE. *"Fatigue of Light Metal Alloys,"* by R. L. Templin, *Metal Industry* (London), vol. 55, No. 14, October 6, 1939, pp. 315-317. This article was taken from the August issue of *"Metals and Alloys."* The article deals with the factors affecting fatigue values and then discusses the conclusions which might be drawn from fatigue values obtained from laboratory tests. Fatigue strengths of the light metal alloys are relatively less than the values for the heavier metals. Light alloys have improved and are improving but it seems that there will always be the problem in the design of light alloy structures, when subjected to repeated loads. Such factors as actual maximum stresses, actual stress distribution, probable number of repetitions of stress expected during the life of the structure and the fatigue strengths of the metals, if paid attention to, will solve many fatigue problems. (A1.)

IRON CASTABILITY. *"Alloys Effect the Castability of Iron,"* by Herman C. Aufderhaar, *The Foundry*, vol. 67, No. 11, November, 1939, pp. 30-31, 104, 106, 108. This paper covers the effect of different alloys on the castability of iron. The author has gone into the investigation giving his ideas, as well as others, on the effect that such alloys as nickel, molybdenum, bismuth and many others have on the effect of castability. He has set aside important factors in the influence on castability such as melting points of numerous alloys and the importance of rate of solution. Three procedures are discussed mentioning how alloys were added; furnace additions, ladle additions and spout additions. The alloys are added in certain forms such as briquets or lump form and the reasons of their importance when applied in that form. These alloys have been divided, by the author, into different classes. Low alloys as irons containing under 1.50 per cent of alloy, medium alloy group are alloy irons having an alloy content between 1.50 and 12 per cent. The high alloy group are also pointed out and discussed by the author. (A1.)

MELTING. *"General Principles Applicable to the Compounding of Alloys by Melting,"* by Albert Portevin, *Foundry Trade Journal*, vol. 61, No. 1203, September 7, 1939, pp. 165-168. This is the last section of this continued article and is divided into two parts; melting conditions and the compounding of industrial alloys and summary and conclusions. The first part covers a wide range of subjects and many important factors are pointed out. Such items of interest to foundrymen are fusibility and liquid miscibility, volatibility, chemical changes, oxidation and absorption of gas, phenomena occurring on the addition of a solid component to the molten metal and many other articles of interest. The second section is composed of compounding of alloys in the foundry, choice and compounding of master alloys or additive alloys and compounding of master alloys. (A1.)

PHOSPHOR BRONZE. *"Making Phosphor Bronze,"* by N. K. B. Patch, *The Foundry*, vol. 67, No. 11, November, 1939, pp. 34, 96, 98, 100. The problem of making phosphor bronze is to make the highest possible quality. In order to accomplish this certain steps must be followed and one of the most important is to give the scrap a chemical analysis. In the production of this production it is also necessary to maintain an accurate control of the phosphorus. The paper also emphasizes the fact that phosphorus is used as a deoxidizer in the rolling mills for some certain alloys. The ratio of tin to copper is discussed and pointed out that a ratio of 6½ per cent to insure the development of the desirable delta constituent. The presence and reverse effect of arsenic is noted in this article. A chart showing typical examples of phosphor bronzes are pointed out for the reader's interest. (A1.)

Aluminum Alloys

MACHINABILITY. *"Machining of Aluminum and Its Alloys,"* by J. H. Dickin and G. A. Anderson, *Metal Industry* (London), vol. 55, No. 10, September 8, 1939, pp. 221-226. Since the development of aluminum in the machining field rapid strides have been taken through means of various testing methods in order to prove the machinability of any particular alloy. It was proved, through the helical test, if an alloy had good machining qualities, smooth, clean grooves with little tearing of the sides were produced, on the other hand poor machining alloys gave a generally rough and torn surface. Facing tests were made to determine the general turning properties of cast alloys. A further test is made to discover the free-cutting properties. The free-cutting, turning and machining properties of aluminum, cast alloys and wrought alloys are pointed out. Free-cutting qualities of magnesium-aluminum series and the copper-magnesium-aluminum series are discussed, pointing out the fact that the heterogeneity of the metal itself helps free-cutting. The qualities of lead-bearing alloys are also brought for the reader's interest. Recommended procedure for cutting are primarily intended for pure aluminum and medium-strength alloys. Numerous subjects are included in the last few paragraphs of the article, including turning and boring, speeds and feeds, lubricants, planing and shaping, milling, drilling, sawing, etc. (A1.)

Bronze Castings

SELECTION. *"Selecting Bronze for Castings,"* by C. H. S. Tupholme, *Canadian Metals and Metallurgical Industries*, vol. 11, No. 9, September, 1939, pp. 226, 228. This paper is a study of bronzes and their uses in various forms of everyday work. The effect of numerous alloying elements in bronze; such as a copper-tin-bronzes that receive over 16 per cent tin become too brittle for ordinary purposes. Many other examples are cited. The centrifugal process of making bronze castings was developed for one particular job and has now developed into a widespread industry for making ball and roller bearings, bushes and slip rings. However, many difficulties have been encountered in commercial production of these materials. Choice of raw materials, especially copper, is stressed in the last paragraph of this article. (A1.)

Bronze, Leaded

BEARING ALLOYS. *"Recommendations for Three Leaded-Bronze Bearing Alloys," Foundry Trade Journal*, vol. 61, No. 1201, August 24, 1939, pp. 135-136. This is the report on the investigation of three compositions of leaded bronzes. Three casting temperatures were chosen and one large and one small test bar was cast at each temperature. Results of many of these tests are shown in the tables that this article contains. (A1.)

Cast Iron

LADLE ADDITIONS OF GRAPHITE. *"Influence of Graphite Ladle Additions on the Mechanical Properties of Gray Cast Iron,"* by A. H. Dierker, R. P. Schneider and H. H. Dawson, *Ohio State University Studies Engineering Series*, vol. 8, No. 4, July, 1939, pp. 3-6. The primary object of the investigation was to determine the effect of graphite ladle additions on mechanical properties and on the chilling tendency of cast iron. The results of the investigation indicated that graphite ladle additions do definitely reduce the chilling tendency of cast iron. The results also

showed that despite the reductions in the tendency to chill, the mechanical properties of iron castings are not affected in any important degree by small additions of graphite at the cupola spout. (C.I.)

Cast Iron Pipe

SPECIFICATIONS. *"Specifications for Cast Iron Pit Cast Pipe for Water or Other Liquids," American Standards Association,* July, 1939. These specifications are tentative and are pre-printed in this form for the purpose of obtaining final approval from the members of committee 21A as well as from the constituent associations. This booklet also contains a manual that is intended to explain the new principles and methods which have been used by committee A21 in the computation of standard pipe thicknesses which are included with the specifications for pit cast and other types of cast iron pipe. The last pages of the book contain the proposed American Standard for Cement Mortar Lining for Cast Iron Pipe and Fittings. (C.I.)

Cement Molding

RANDUPSON PROCESS. *"Producing a Large Iron Casting by the Randupson Process,"* by G. Longden, *Foundry Trade Journal,* vol. 61, No. 1203, September 7, 1939, pp. 169-170. The Randupson process, first used in France, is based on the principle of using molds made from silica sand and cement, with water added. Many advantages are claimed for this process but the one of most importance is the high quality of the casting. The high quality of the work can be attributed to the fact of the high resistance of the cement-sand structure to the molten metal. A diagram showing the construction of a mold is also shown. (C.)

Converter

KNOWLEDGE. *"A Little Knowledge Is a Dangerous Thing,"* by John Howe Hall, *The Foundry,* vol. 67, No. 11, November, 1939, pp. 35, 86, 89. This is an article coming to the defense of converter steel due to its high sulphur content. This paper is showing how the problem has been overcome to some extent by treating the converter charge with soda ash, either in the cupola, in the iron ladle, or in both. This particular section of the author's article has to do with a side blow converter, giving a step by step account of the operation of this certain type of furnace. (F.)

Electric Melting

POWER CONSUMPTION. *"Power and Electrode Consumption in Electric Furnaces," Foundry Trade Journal,* vol. 61, No. 1203, September 7, 1939, p. 174. One of the main costs in the making of steel in the electric-arc-furnace is electric power and electrodes. Power costs not only depend upon the make-up of the furnace, but also on the conditions under which the furnace is run, taking into consideration the processes taking place in the furnace, its dimensions, and the rating of the converter furnishing the power. Observations have been made on a fourteen and a seven ton arc furnace and a coreless induction furnace of 4.5 tons capacity at a steel company in Sweden. (F.)

Furnaces

COPPER AND BRASS. *"New Design in Copper and Brass Furnaces,"* by H. H. Heyn, *Industrial Gas,* vol. 18, No. 4, October, 1939, pp. 12-15. This article describes some new representative furnace installations incorporating various principles of improved design necessitated by revolutionary changes in the forming and processing of copper and brass. These units have been developed to fit into new types of production and fulfill rigid specifications with especial attention to mechanization. There are ten pictures of these new furnaces and they are all discussed in detail. Plant operations have been mechanized, straight-line production and automatic control introduced, metallurgical structure and surface conditions improved. (F.)

Health

SAFETY. *"Fashions in Safety,"* by R. E. Tugman, *Safety Engineering,* vol. 78, No. 3, September, 1939, pp. 6-8, 12. Protective clothing and appliances are necessary to safeguard the worker from the effects of imperfect plant design. Many risks can be avoided if the right steps are taken towards the use of gloves and goggles during working hours. Unless the design is adapted to the worker in a comfortable and protecting manner it will not be used and accidents will be frequent. This paper described the efforts which have been made to supply the most suitable protective clothing and appliances for a particular set of conditions. The use of goggles, aprons, respirators, gloves and safety education are pointed out as important factors in keeping a plant safety conscious. (S.)

Machine Tools

CASTINGS. *"Role of Nickel in the Machine Tool Industry,"* by J. W. Sands and D. A. Nemser, *Metals and Alloys,* vol. 10, No. 9, September, 1939, pp. 261-268. For the past few years great strides have been taken in the materials which have been employed in the composition and make-up of machine tools. There has been a wider use of alloy cast irons and steels and of non-ferrous alloys which has resulted in machines insuring greater accuracy and efficiency. Through authorities that are very close to this industry a close study is disclosed in this article of this evolution. It is a revelation of the application of metallurgical engineering to an industry which is basic in its nature. (C).

Magnesium Alloys

AIRCRAFT. *"Magnesium Alloys and Their Uses in Aircraft,"* by A. W. Winston, *Metal Progress,* vol 36, No. 3, September, 1939, pp. 237-242. When magnesium alloy parts have received a chemical treatment and been painted, they have given very good service. Their application in the aircraft field has been developed because of its lightness, economy and safety. It is believed that there is a place in the field for magnesium alloy parts and it is hoped that in the near future engineers and designers will improve the performance of these alloys in the aviation field. (A1.)

FOUNDRY PRACTICE. *"Non-Ferrous Foundry Practice,"* by J. Laing and R. T. Rolfe, *The Metal Industry* (London), vol. 55, No. 9, September 1, 1939, pp. 205-208. The influence of manganese, cadmium, silver, tin, lead, copper, nickel, silicon and iron added to or present in magnesium alloys is discussed briefly in this article. Attention is paid to the constitution of aluminum - magnesium alloys, the heat treatment of such alloys, molding practice, melting practice and casting temperature of this alloy. (A1.)

PRODUCTION. *"Magnesium and Its Alloys,"* by J. L. Haughton, *The Metal Industry* (London), vol. 55, No. 9, September 1, 1939, pp. 201-203. This article is concerned with the recent developments in the production and application of magnesium alloys in Great Britain. Two main lines of investigation were conducted: the effect of the addition of new elements to magnesium and of the different methods of working these alloys and the constitution of a number of these alloys has been investigated in order to assist in the study of mechanical properties. Research into the properties of new combinations of magnesium with other elements is discussed. (A1.)

Melting Practice

LIGHT ALLOYS. *"Light-Alloy Melting Practice,"* by W. C. Devereux, *Canadian Metals and Metallurgical Industries,* vol. 11, No. 9, September, 1939, pp. 218-220. This paper, that was presented at the International Foundry Congress, points out some practical observations made on various types of furnaces to show advantages and disadvantages of the many different methods adopted according to the variety of materials produced. Aluminum alloys were first melted in pit-type furnaces, then tilting furnaces were used and then followed by low-frequency induction melting which appears to be the answer to all the problems the other furnaces seem to possess. Performance comparisons of an oil-fired crucible furnace and a low-frequency induction furnace were made and the results are shown in chart form. It is also pointed out in this article that many of the difficulties of the open-hearth could be overcome by the use of a rotary cylindrical type furnace. Bowl furnaces are also discussed. Furnaces for magnesium melting are limited in scope by the characteristics of the metal and can be grouped as follows: crucible furnaces employing iron pots either lift-out or tilting type and bale-out furnaces with a totally enclosed top. (F.)

Metallography

MICRO-STRUCTURE. *"Metallography, Old and New,"* by Bernard Collitt, *Canadian Metals and Metallurgical Industries,* vol. 11, No. 9, September, 1939, pp. 221-222, 224, 237. The study of metallography is divided into five branches: (1) the study of fractures, (2) the study of macostructure, (3) examination of the microstructure, (4) radiography and (5) analysis by diffraction of X-rays. These five points are thoroughly discussed in this article and makes it apparent that every year new discoveries are made through the further use of this instrument. (A.)

Non-Ferrous Founding

MAGNESIUM ALLOYS. *"Non-Ferrous Foundry Practice,"* by J. Laing and R. T. Rolfe. *The Metal Industry* (London), vol. 55, No. 8, August 25, 1939, pp. 169-172. In working magnesium alloys cold process is limited but can more readily be hot-pressed. The metal endowed with good cutting speeds and enabling economy in production. This article also pointed out that these alloys have numerous disadvantages such as low modulus of elasticity, a higher notch sensitivity, a higher thermal expansion and a pronounced weakness at higher temperatures than aluminum. Improvements have been made to correct many of these difficulties in the last few years. A list of alloys used in industry are discussed by the author and the effects of the various constituents when added to these alloys. (A1.)

FOUNDRYMEN SELECT CHICAGO FOR 1940 CONVENTION
Chicago has been chosen as the host city for the 1940 Foundry and Allied Industries Show to be held in connection with the 44th Annual Convention of the American Foundrymen's Association, May 4 to 10, 1940. Some of the advantages which Chicago offers are:
1. A Central Geographical Location.
2. An up-to-the-minute building—The International Amphitheater—unsurpassed in its facilities for operating exhibits.
3. Accommodations for holding all convention meetings and exhibits in one central location.
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